Industrial **BIO-TEST** *Laboratories, Inc.*

SCREEN MONITORING AT ALLEN STATION

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ABSTRACT

The traveling screens at Allen Station were monitored twice monthly from 6 September 1973 through 20 August 1974. Approximately 53,000 fish belonging to 18 species were entrapped. The majority (98.8%) were threadfin shad with bluegills being the most numerous of the other species collected. An estimated total of about 830,000 fish would be entrapped annually, with the majority (95.4%) of threadfin mortality attributable to winter low temperatures. Fish loss of several other impinged species could be reduced by omitting large numbers of decomposing and diseased fish. Intake flow rates had no consistent effects on numbers of fish impinged. Eight other species present in the area were not represented in traveling screen collections.

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I. Introduction

The impingement of fish on the trash barrier systems of power plants has received increasing attention in recent years. This study is intended to provide an estimate of the numbers and types of fish impinged on the traveling screens of the Allen Station, Duke Power Company, located on Lake Wylie, North Carolina. The study is further intended to establish a basis upon which predictive estimates of impingment at proposed power plants could be made.

Attempts were made to distinguish between those fish which were dead or damaged as a result of impingement and those which were impinged as a result of prior death or disease. The difference is significant in that, on the one hand, impingement would be a cause of fish loss while, on the other hand, impingement may merely reflect entrapment of moribund fish already suffering from the debiliting effects of other factors.

Tables summarizing observations of fish collected from the Allen Station traveling screens are presented in Appendix A.

II. Summary and Conclusions

The Allen Station traveling screens were monitored twice monthly from 6 September 1973 to 20 August 1974. Summary and analysis of data collected during this and part of a concurrent field study (Johnson 1974) leads to the following conclusions:

1. Eighteen species were impinged on the Allen Station traveling screens. An estimated total of 53,021 individual fish were collected, allowing an estimated annual total of about 830,000 fish to be projected.

2. Threadfin shad was the predominant species with a total of 52,380 individuals, representing 98.8% of the total catch.

3. Bluegills, gizzard shad, channel and white catfish and yellow perch were the next most numerous species. Respective totals of 248, 148, 79, 51 and 47 for each species were collected. These, combined with threadfin shad, represented 99.9% of the overall catch.

4. Intake flow rates varied from 58.7% to 100% of rated capacity. Variations in intake flow rates had no apparent effect on numbers of fish entrapped on the traveling screens.

5. The winter during the sampling period was relatively mild suggesting that annual estimates of threadfin shad impingement may be conservative. Many of the threadfin shad collected would have died as a result of low temperatures anyway.

6. Catches of bluegills, redbreast sunfish, yellow perch, channel catfish and white catfish included diseased or decomposing individuals which could be

discounted from fish loss due to impingement.

7. Threadfin shad were collected in very low numbers from the area concurrently sampled by various fishing methods. This tends to support the suggestion that threadfin shad die as a result of cold shock and that entrapment at Allen Station reveals, rather than causes, that die-off.

8. Eight additional species were collected in the field which were not represented in screen counts. Two impinged species were not collected in nearby field sampling.

III. Materials and Methods

A. Site Description

Allen Station is located on the northern end of Lake Wylie in North Carolina (Figure 1). The 12,455 acre Lake Wylie impoundment was completed in 1925. Impounded water is used for hydroelectric generation at Wylie Station. Allen Station, the second generating facility on Lake Wylie, became operational in 1957. It is a coal-fueled steam generating plant with 5 generators capable of producing 1155MWe. Condenser cooling is accomplished by passing Lake Wylie water through a once-through open loop system. Water is drawn from the Catawba River arm of the lake, passed through the condensers and discharged via a mile-long canal into the South Fork Catawba River.

The Allen Station intake structure (Figure 2) consists of 10 pumps capable of circulating 1215 cfs (545,000 GPM, 2062m^3/min), traveling screens with 3/8" (1cm) square mesh opening and vertical trash racks with bars at 3" intervals. Units 1 and 2 share a common water tunnel as do Units 3 and 4. Unit 5 is separate. The elevation of the intake opening is 549.6 ft MSL; full pond is at 569.4 ft and maximum drawdown is 10 ft. Water velocity at the traveling screens depends upon 2 factors: number of pumps operating and lake level (Table 1).

The Catawba River at Allen Station is approximately 1500 ft wide. The main channel, approximately 30 ft deep, is near the west shore about 400 ft east of the intake structure. The bottom from the intake structure to the edge of the main channel is more or less flat with a depth of about 15 ft.

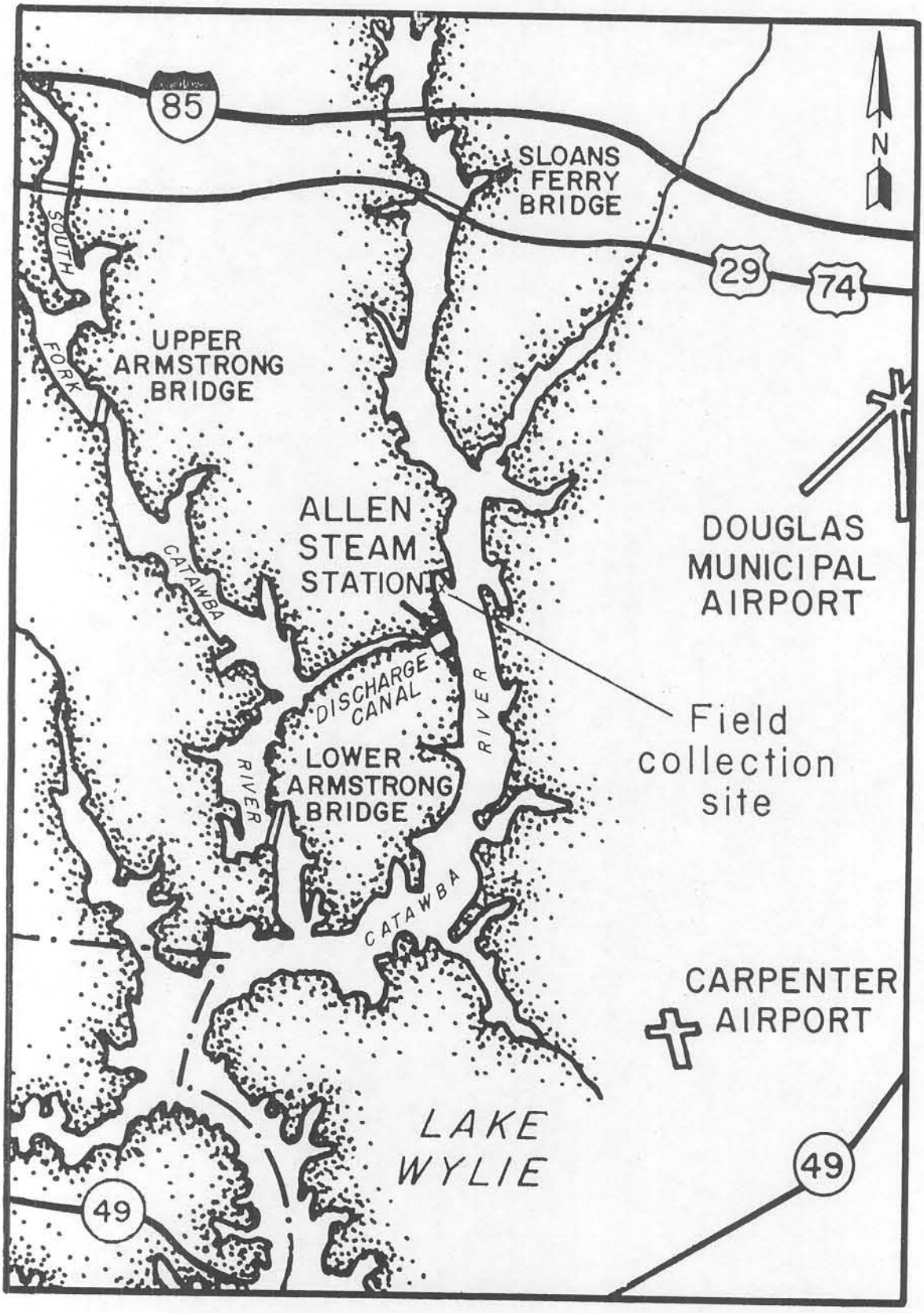

Figure 1. Map of Lake Wylie, North Carolina showing location of Allen Station and a nearby representative field fish sampling location.

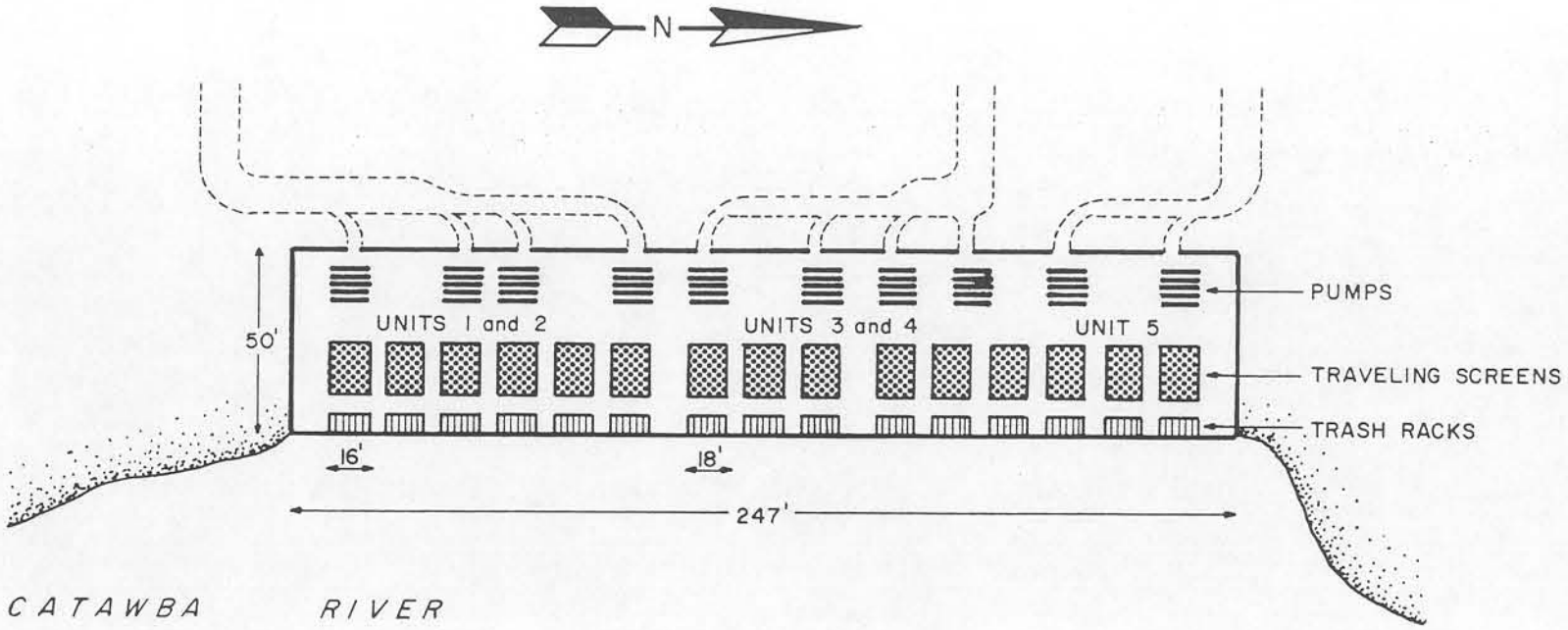

Figure 2. Diagrammatic top view of Allen Station intake structure.

Table 1. Water velocities (cm/sec) at Allen Plant intake structure.

Unit:	1 & 2		3 & 4		5	
Pumps Operating:	1	2	1	2	1	2
At Full Pond Elevation:						
Trash rack velocity (cm/sec)	3.7	6.1	5.5	9.2	5.5	9.2
Screen velocity (cm/sec)	4.6	7.6	6.7	11.0	6.7	11.0
At Maximum Drawdown Elevation:						
Trash rack velocity (cm/sec)	6.1	10.1	9.2	15.3	9.2	15.3
Screen velocity (cm/sec)	7.3	12.8	10.7	18.0	10.7	18.0

Drawdown on the day of bottom profiling was approximately 5 ft so depths will vary by ±1-5 ft, depending on drawdown. The shoreline for several hundred yards north and south of the intake structure is unobstructed sand beach.

B. Monitoring Procedure

The traveling screens are positioned behind the trash racks and are made of woven wire mesh with 3/8" (1cm) square openings. These screens form a continuous belt which travels vertically when activated. High velocity water jets eject accumulated materials from the screens into a sluiceway located immediately in front of the traveling screens. During the normal screen washing operation debris washed from the screens is carried several hundred yards downstream via the sluiceway and returned to Lake Wylie.

Screens were monitored by placing a collection basket made of the same material as the screens in the sluiceway immediately below the intake structure. The screens were turned and washed and all materials were collected in the basket.

Plant personnel were requested to wash the screens at midnight on the day prior to monitoring in order to initiate a 24-hour sampling period. Screens were then monitored at 0800, 1600 and 2400 hours the following day. Alternate Tuesdays of each month were selected as affording the best opportunity for sampling. Screens were generally turned by unit. That is, each generating unit has 3 screens which were generally sampled simultaneously. On several occasions abundant debris required washing the 15 screens separately. Lack of debris and impinged fish at other times allowed washing the screens of 2 or

more units simultaneously. Thus, variations at each unit intake as well as diurnal impingement variations, if any, could be detected.

Plant operating conditions were noted during each 8-hour sampling period. Observations included time, number of generating units operating, number of circulating pumps operating and intake temperature. On occasion, traveling screen mechanisms malfunctioned and these were also noted. Intake flow in gallons per minute (GPM) was estimated from the rated capacities of those circulating pumps in operation.

All fish collected were usually identified to species, counted, weighed and measured. When numbers of fish were too large for individual measurement, subsampling was utilized. The total weight of fish was noted and a random subsample of 10-100 fish was taken. The fish in this subsample were weighed and measured separately. An estimate of total number, mean length and mean weight could then be made. Standard and total lengths of fish were measured to ±0.5 cm and weights over 5g were measured to the nearest gram.

Observations on the apparent physical condition of impinged fishes were also noted. These included alive or dead, diseased, state of decomposition and mechanical damage due to abrasion. The latter encompassed injury ranging from loss of a few scales to laceration of skin and flesh. Fishes in states of advanced decomposition (dead longer than 8 hours) or with evidence of extensive parasitic infestation could then be excluded from estimates of fish loss due to impingement.

C. Field Procedure

As part of a separate study (Johnson 1974) a fish collection site was located in a cove 1/2 mile above the intake structure. The site was selected as being representative of the local inshore area and generally outside the zones of influence of any known outfalls. Fish were collected at this site on a monthly basis during the period September 1973 through August 1974.

Fish collection methods included electroshocking, gill netting and seining. Electroshocking was conducted with a 230 volt, 3000 watt, 3-phase boat-mounted boom shocker. Shocking was done in the littoral area of the site in depths ordinarily of 6 ft or less. Electroshocking was performed for about 20 minutes on each monthly sampling date.

Gill nets were multiple-panel, nylon thread with 10-foot sections of various mesh sizes. The nets were set in duplicate at the location and were fished overnight for about 16 hours.

A 30-foot long, 6-foot deep, 1/4 inch mesh minnow seine was also used. Two or more seine hauls were made in a suitable littoral area of the site. On two occasions (December and January) lake levels were too high to permit effective use of the seine in the area.

All 3 sampling techniques were utilized each month within a 2-3 day period depending upon prevalent conditions. All fishes collected were identified to species, weighed and measured and either returned to the water alive or sacrificed for stomach content analysis. Shocked threadfin shad were not generally collected in as large numbers as possible. Schooling and patchy

distribution were assumed to lead to inaccuracy in quantitative estimation so that only subsamples for length and weight were taken.

IV. Results and Discussion

A. Station Monitoring Statistics

Impingement monitoring at Allen Station began on 6 September 1973 and continued at 2-3 week intervals until 20 August 1974. Plant operations were at capacity on 10 of the 24 sampling dates (Table 2). Unit 3 was shut down on 20 November and 11 December 1973. Unit 4 was not operational on 5 March 1974. Units 1 and 2 were off line on 4 April 1974 and Unit 1 was still not operating by 16 April 1974. Unit 5 was shut off for repairs on 2 July 1974 (Table 2).

Collection periods were for 16 hours instead of 24 hours on 11 December 1973 and 26 February 1974.

Occasionally, during periods of non-peak load, various circulating pumps were shut down. These periods were noted during sampling, and intake flow estimates were reduced accordingly (Table 2). At full capacity, rated flow at Allen Station is 544,960 GPM (J. Bailes, pers. comm.). Intake varied from 57.8% to 100% of rated flow and was not found to appreciably influence numbers of fish impinged. Units 5 and 1 were consistently higher in entrapped fish and debris. This may reflect the higher intake volume of Unit 5 pumps and the extreme upstream and downstream locations of these intakes.

B. Fish Impingement

Eighteen species were impinged at various times on the Allen Station traveling screens (Figure 3). Threadfin shad and bluegills were collected in every month. Threadfin shad were absent on only one occasion while bluegills were not collected on 3 of the 24 sampling dates. Black crappie, mosquitofish

Table 2. Estimated flow rates (GPM) at Allen Steam Station on sampling dates when various generating units and/or circulating pumps were not operational.

Sampling Date	Pumps Off-Line	Estimated Flow (GPM)	% Capacity
1973			
6 September	None	544,960	100.0
21 September	None	544,960	100.0
2 October	None	544,960	100.0
16 October	None	544,960	100.0
6 November	None	544,960	100.0
20 November	1B, 3A, 3B	377,210	69.2
11 December	1B, 3A, 3B	377,210	69.2
18 December	1B, 3B	440,210	80.8
1974			
8 January	1B, 3B, 4B	377,210	69.2
22 January	1B, 3B	440,210	80.8
12 February	1B, 3B	440,210	80.8
26 February	1B, 3B	440,210	80.8
5 March	1B, 4A, 4B	377,210	69.2
19 March	4A	481,960	88.4
4 April	1A, 1B, 2A, 2B, 3B	315,000	57.8
16 April	1A, 1B, 3B	398,460	73.1
7 May	1B	503,210	92.3
21 May	1A	503,210	92.3
4 June	None	544,960	100.0
18 June	None	544,960	100.0
2 July	5A, 5B	418,960	76.8
16 July	None	544,960	100.0
6 August	None	544,960	100.0
20 August	None	544,960	100.0

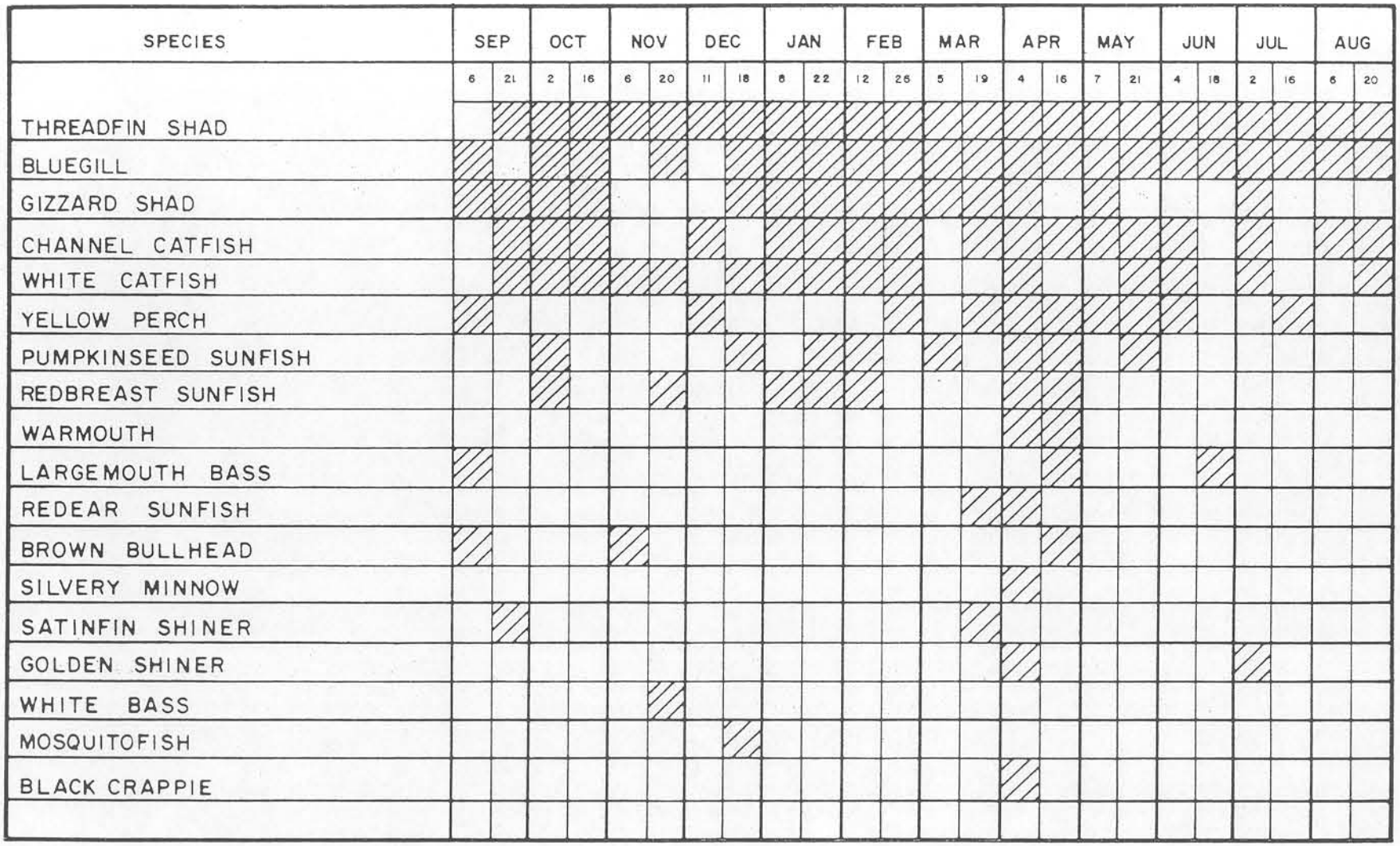

Figure 3. Occurrence of Lake Wylie fishes at Allen Station traveling screens on various sampling dates during the period 6 September 1973 through 20 August 1974.

and silvery minnows were each taken on only one occasion. White bass, warmouth, redear sunfish and golden and satinfin shiners were taken twice and largemouth bass were found entrapped three times (Figure 3).

The most numerous species was threadfin shad at 52,380 (Table 3), comprising 98.8% of the total (53,021). Of those shad 49,952 (95.4%) were impinged only on sampling dates between 20 November 1973 and 22 January 1974. They were more or less evenly distributed over each sampling day. Bluegills, gizzard shad, channel catfish, white catfish and yellow perch were also taken in appreciable numbers (248, 148, 79, 51 and 47 respectively) (Table 3). Most (50-65%) of the bluegills and yellow perch were collected in April. Twenty-one pumpkinseed and 13 redbreast sunfish were other relatively numerous species taken. Fewer than 10 individuals of each of the other 10 species were entrapped on the 24 sampling dates with a solitary black crappie being the lowest number of any species collected (Table 3).

Johnson (1974) reported collecting 24 species in the area. Mosquitofish and silvery minnows were absent from field collections. No individuals of the other 8 species were taken from the Allen Station traveling screens during the monitored periods.

Lengths and weights of impinged fish varied widely. Threadfin shad total lengths varied from 2 to 15 cm with the majority in the 5-8 cm size class. Body weights of threadfin shad varied similarly from 1-15g with the largest percentage weighing 4-6g. Of the 5 next most numerous species, bluegills ranged 2-16 cm, <5-75g with most individuals between 5-10 cm and 5-30g.

Table 3. Fish collected from Allen Station traveling screens, 6 September 1973 through 20 August 1974.

Species	Collection Date 9/6	9/21	10/2	10/16	11/6	11/20	12/11	12/18	1/8	1/22	2/12	2/26	3/5	3/19	4/4	4/16	5/7	5/21	6/4	6/18	7/2	7/16	8/6	8/20	Total Number
Threadfin shad	-	4	98	2	400	5480	336	25000	10630	8536	384	629	62	8	138	114	9	423	151	1	1	3	4	18	52380
Gizzard shad	9	5	36	2	-	-	-	1	3	3	2	7	3	8	38	-	4	-	-	-	4	1	2	-	148
Golden shiner	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	2
Satinfin shiner	-	3	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	4
Silvery minnow	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	4
White catfish	-	4	4	1	1	7	-	1	2	3	2	3	-	-	3	-	-	3	1	-	12	-	-	4	51
Channel catfish	-	1	5	1	-	-	1	-	18	19	2	5	-	1	4	1	9	4	2	-	2	-	1	3	79
Brown bullhead	1	-	-	-	2	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	4
Mosquitofish	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Largemouth bass	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	2	-	-	-	-	4
Bluegill	4	-	11	2	-	1	-	5	1	2	7	3	4	5	49	74	7	22	11	5	18	7	2	6	248
Pumpkinseed	-	-	1	-	-	-	-	2	-	1	1	-	2	-	9	4	-	1	-	-	-	-	-	-	21
Redbreast sunfish	-	-	1	-	-	1	-	-	1	1	2	-	-	-	2	2	-	-	1	2	-	-	-	-	13
Redear sunfish	-	-	-	-	-	-	-	-	-	-	-	-	-	1	3	-	-	-	-	-	-	-	-	-	4
Warmouth	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	6	-	-	-	-	-	-	-	-	7
Black crappie	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1
Yellow perch	1	-	-	-	-	-	1	-	-	-	-	2	-	2	27	10	1	1	1	-	-	1	-	-	47
White bass	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2
Total Number	16	17	146	8	412	5490	338	25011	10625	8565	400	651	71	26	280	213	30	454	167	10	38	12	9	32	53021
Temperature (°C)	28.0	26.0	25.0	24.0	17.5	15.0	11.0	9.0	9.5	10.5	9.0	9.5	12.0	12.0	15.0	15.0	20.0	21.5	23.5	25.5	25.5	28.0	27.5	26.5	

Gizzard shad were 5-30 cm long and weighed <5-170g although most were in the 5-15 cm category weighing 10-25g. Channel catfish ranged 5-32 cm in length and weighed 5-16g; most channel catfish taken were 5-15 cm long weighing 5-25g. White catfish lengths and weights were similarly distributed. Total length range for yellow perch was 8-16 cm with a body weight range of 5-65g. Most of these were adults taken in April ranging 10-13 cm and 20-30g.

The total time spent monitoring the Allen traveling screens was 560 operating hours, 6.4% of one operational year. Thus, estimates of numbers and total weight of fish which can be anticipated annually can be made by multiplying impingement totals by 15.64 (Table 4). Seasonal and size distribution patterns would be assumed to be similar.

Exclusive of threadfin shad, many of the fish taken could be classed into two broad categories. These were, on the one hand, small individuals which were alive and bore little or no evidence of mechanical damage or disease. On the other hand, many of the larger individuals of several species were decomposing, having obviously been dead longer than the 8 hours since the last screen washing. Examples of groups with this distributional pattern were the sunfishes, yellow perch and channel and white catfish (Table 5).

Generally those individuals classed as diseased (alive or dead) and as dead and decomposed could be excluded from impinged fish counts since they were dead already. Thus, impingement can be reduced to effective fish loss by: 5.3 and 10.2% for threadfin and gizzard shad; 25.7, 48.8 and 9.6% for bluegills, redbreast and pumpkinseed sunfish; 40.4% for yellow perch and; 54.4 and 58.9%

Table 4. Estimated annual total numbers and weight (kg) of fish impinged at Allen Station based on 560 sampling hours during the period 6 September 1973 through 20 August 1974.

Species	Number Collected	Estimated Annual Count	Estimated Annual Weight (kg)	Percent Occurrence (%)
Threadfin shad	52,380	819,372	1,736	98.8[a]
Bluegill	248	3,879	38	38.7[b]
Gizzard shad	148	2,315	46	23.1
Channel catfish	79	1,283	27	12.3
White catfish	51	766	21	8.0
Yellow perch	47	735	18	7.3
Pumpkinseed	21	329	2	3.3
Redbreast sunfish	13	203	3	2.0
Warmouth	7	110	6	1.1
Largemouth bass	4	63	9	0.6
Redear sunfish	4	63	1	0.6
Brown bullhead	4	63	4	0.6
Silvery minnow	4	63	<1	0.6
Satinfin shiner	4	63	<1	0.6
Golden shiner	2	31	<1	0.3
White bass	2	31	2	0.3
Mosquitofish	2	31	<1	0.3
Black crappie	1	16	1	0.2
Total:	53,021	829,372	1,918	-

[a] Percent occurrence of total fish impinged.
[b] Percent occurrence of fish impinged exclusive of threadfin shad.

Table 5. Percent occurrence of Lake Wylie fish impinged at Allen Station in various categories of physical condition.

Species	Number Collected	Percent Occurrence						
		Alive			Dead			
		NAD[a]	Dis[b]	Mech[c]	NAD	Dis	Mech	Decom[d]
Threadfin shad	52,380	0.0	0.0	11.4	0.0	<0.1	83.2	5.3
Bluegill	248	43.1	6.0	3.2	18.1	1.6	9.7	18.1
Gizzard shad	148	0.0	0.7	12.2	0.0	1.4	77.7	8.1
Channel catfish	79	40.5	12.7	1.3	1.3	13.9	2.5	27.8
White catfish	51	21.6	2.0	9.8	5.9	9.8	3.9	47.1
Yellow perch	47	2.1	4.3	2.1	46.8	2.1	8.5	34.0
Pumpkinseed	21	38.1	4.8	0.0	19.0	4.8	33.3	0.0
Redbreast sunfish	13	53.8	7.7	0.0	15.4	7.7	7.7	7.7
Warmouth	7	71.4	0.0	0.0	0.0	0.0	14.3	14.3
Largemouth bass	4	25.0	0.0	25.0	25.0	0.0	25.0	0.0
Redear sunfish	4	25.0	0.0	25.0	0.0	0.0	50.0	0.0
Brown bullhead	4	0.0	25.0	0.0	0.0	25.0	0.0	50.0
Silvery minnow	4	0.0	0.0	0.0	0.0	0.0	100.0	0.0
Satinfin shiner	4	75.0	0.0	0.0	0.0	0.0	0.0	25.0
Golden shiner	2	0.0	0.0	0.0	0.0	0.0	100.0	0.0
White bass	2	0.0	0.0	100.0	0.0	0.0	0.0	0.0
Mosquitofish	2	100.0	0.0	0.0	0.0	0.0	0.0	0.0
Black crappie	1	0.0	0.0	0.0	100.0	0.0	0.0	0.0

[a] NAD = No apparent damage or disease.
[b] Dis = Extensively diseased, moribund.
[c] Mech= Mechanical damage; loss of scales to laceration.
[d] Decom = Decomposed; dead longer than 8 hrs.

for channel and white catfish (Table 5). Among the sunfish and catfish species many small, apparently healthy individuals were collected (Table 5) which, when returned to the water, displayed no deleterious effects. Their recovery, though uncertain, seemed likely.

Threadfin shad constitute a unique group in that 83.2% of these fish were in the recent (less than 8 hours) dead, mechanically affected group (Table 5). Evidence exists, however, that many of these animals might have died anyway even had they not been impinged (Miller and DeMont 1972; McNaughton 1966; Strawn 1965). Those fish taken alive displayed a weakness which may have been due to approaching cold death rather than impingement. It is not certain how many threadfin shad would have died anyway. It is likely that entrapment at Allen Station merely brought to light the large number of threadfin shad which die off annually as a result of cold winter temperature. Indeed McNaughton (1966) has asserted that the Allen Station discharge prevents a total kill of threadfin shad during winter in Lake Wylie.

The winter of this study was relatively mild for the area. It is probable that the estimated annual number of threadfin shad impinged (Table 4) is conservatively low for years with longer periods of colder lake temperatures.

Relatively high numbers of bluegills, yellow perch and gizzard shad impinged in April (Table 3) could be attributed to the fact that the trash racks in front of the intake structure had not been cleared of debris for some time (2-3 weeks) prior to sampling. The high number of perch corresponds temporally with spawning in the species, however, and may reflect a weakness

often associated with the post-spawning period.

White and channel catfish occurred in relatively high numbers also. Casual observations revealed that large numbers of these dwelt in the immediate vicinity of the intakes, feeding on incoming organisms and detritus.

Redear sunfish and warmouth were also taken only in spring corresponding to spawning in the species. Other fish were considered to be largely of fortuitous occurrence with no clear or consistent correlation between numbers impinged and plant activities or seasonal or other variations.

C. Field Fish Collections

Sixteen of the 18 species collected at the Allen Station traveling screens were also collected during a concurrent field fisheries study (Johnson 1974) (Figure 4, Table 6). Silvery minnows and mosquitofish were not encountered. In addition, 8 other species collected in the area included: shorthead and smallfin redhorse, quillback, carp, rock bass, longnose gar, Johnny darters, and bluehead chub. None of these 8 species were taken at Allen Station.

A total weight of 182 kg of fish was collected by electroshocking and gill netting at the site near the Allen intake structure. At least 74 kg (41%) represented species not encountered at the traveling screens. Threadfin shad weighing about 111 kg accounted for 90% of the 123 kg total weight of fish entrapped. On the other hand, only 9 individual threadfin shad were collected while electrofishing the area. Johnson (1974) reported threadfin shad frequenting other Lake Wylie locations in much larger numbers but sampling was patchy and not quantitative.

SPECIES	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG
THREADFIN SHAD					▨							▨
BLUEGILL	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	
GIZZARD SHAD	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
CHANNEL CATFISH	▨	▨	▨		▨				▨	▨	▨	▨
WHITE CATFISH	▨	▨		▨	▨	▨	▨	▨	▨	▨	▨	▨
YELLOW PERCH		▨	▨	▨	▨	▨	▨	▨	▨			▨
PUMPKINSEED SUNFISH	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
REDBREAST SUNFISH	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
WARMOUTH		▨			▨						▨	▨
LARGEMOUTH BASS	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
REDEAR SUNFISH	▨	▨	▨	▨	▨	▨	▨		▨	▨	▨	▨
BROWN BULLHEAD				▨				▨				
SILVERY MINNOW												
SATINFIN SHINER	▨	▨	▨			▨			▨	▨	▨	▨
GOLDEN SHINER	▨		▨	▨	▨	▨		▨	▨	▨		
WHITE BASS												▨
MOSQUITOFISH												
BLACK CRAPPIE	▨											

Figure 4. Monthly occurrence of Lake Wylie fishes at a field sampling location near the Allen Station intake structure. Collection methods included electroshocking, gill netting and inshore seining. Data taken from Johnson 1974.

Table 6. Percent composition of the Lake Wylie fish community at a representative location near the Allen Station intake structure. Date taken from Johnson 1974. Percent composition of fish impinged at Allen Station is included for comparison.

Species	Percent Composition	
	Impinged Fish	Field Collected Fish
Threadfin shad	98.8[a]	0.8[a]
Bluegill	38.7[b]	30.5[b]
Gizzard shad	23.1	7.7
Channel catfish	12.3	2.6
White catfish	8.0	2.6
Yellow perch	7.3	3.1
Pumpkinseed	3.3	7.2
Redbreast sunfish	2.0	13.5
Warmouth	1.1	0.6
Largemouth bass	0.6	6.5
Redear sunfish	0.6	4.0
Brown bullhead	0.6	0.2
Silvery minnow	0.6	-[c]
Satinfin shiner	0.6	11.4
Golden shiner	0.3	3.1
White bass	0.3	0.2
Mosquitofish	0.3	-
Black crappie	0.2	<0.1

[a] Percent of all fish.
[b] Percent of all fish except threadfin shad.
[c] Not collected.

Bluegills were represented in field collections in numbers slightly smaller (8.2% less) than those at the intake screens (Table 6). They were collected primarily by shocking and seining. Pumpkinseed, redbreast and redear sunfish were taken in the field in somewhat larger numbers (Table 6). More largemouth bass were collected in the field (6.5%) than were impinged (0.4%). Satinfin and golden shiners were also collected in much larger numbers (Table 6). The golden shiners in field samples were larger than those impinged and were collected by gill net. Almost all the satinfin shiners were collected by seine.

Conversely fewer channel and white catfish, yellow perch and gizzard shad were collected in the field than were entrapped. All other species common to both collections occurred in comparably low percentages (Table 6).

Extensively diseased or decomposing fish were absent from field samples although some parasitism was observed (Johnson 1974). No large "kills" of threadfin shad attributable to cold shock were seen while sampling this or other Lake Wylie locations. Sampling methods were not designed for effective collection in the deeper regions of the lake nor for the detection of widely dispersed dead fish.

V. References Cited

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APPENDIX A

Table A-1. Fish collected from Allen Steam Plant traveling screens, 6 September 1973.[a]

Species	Size Class (cm)	Weight Class (g)	Number of Fish Collected	Condition
Gizzard shad	5-27	<5-125	9	9 - alive, mechanical damage
Bluegill	3-16	15-70	4	4 - alive, mechanical damage
Largemouth bass	10	15	1	1 - alive, no apparent damage
Yellow perch	16	45	1	1 - mechanical damage
Brown bullhead	24	145	1	1 - diseased

[a] River temperature 28.0-29.0 C.

Table A-2. Fish collected from Allen Steam Plant traveling screens, 21 September 1973.[a]

Species	Size Class (cm)	Weight Class (g)	Number of Fish Collected	Condition
Threadfin shad	4-6	1-5	6	6 - alive, mechanical damage
Gizzard shad	6-20	5-20	5	5 - alive, mechanical damage
Satinfin shiner	5-6	<5	3	3 - alive, no apparent damage
Channel catfish	13	35	1	1 - alive, no apparent damage
White catfish	5-24	<5-145	4	1 - dead, decomposed 1 - alive, diseased 2 - alive, no apparent damage

[a] River temperatures 25.5-26.5 C.

Table A-3. Fish collected from Allen Steam Plant traveling screens, 2 October 1973.[a]

Species	Size Class (cm)	Weight Class (g)	Number of Fish Collected	Condition
Threadfin shad	5-10	1-5	70	70 - dead, mechanical damage
Gizzard shad	5-20	1-15	56	56 - dead, mechanical damage
Bluegill	5-15	<5-55	10	3 - alive, no apparent damage 1 - alive, diseased 4 - dead, mechanical damage 2 - dead, decomposed
Pumpkinseed sunfish	5	<5	1	1 - alive, no apparent damage
Redbreast sunfish	6.5	5	1	1 - alive, no apparent damage
Channel catfish	6.5-31.5	5-165	5	2 - alive, no apparent damage 3 - dead, decomposed
White catfish	6.5-19.5	5-55	4	2 - alive, mechanical damage 2 - dead, mechanical damage

[a] River temperatures 24.5-25.5 C.

Table A-4. Fish collected from Allen Steam Plant traveling screens, 16 October 1973.[a]

Species	Size Class (cm)	Weight Class (g)	Number of Fish Collected	Condition
Threadfin shad	6.5-7.0	<5	2	2 - dead, mechanical damage
Gizzard shad	10.5-14.5	15	2	2 - dead, mechanical damage
Bluegill	8.0-13.5	5-40	2	2 - dead, mechanical damage
Channel catfish	18.5	60	1	1 - alive, mechanical damage
White catfish	18.5	65	1	1 - alive, mechanical damage

[a] River temperature 23.5-24.0 C.

Table A-5. Fish collected from Allen Steam Plant traveling screens, 6 November 1973.[a]

Species	Size Class (cm)	Weight Class (g)	Number of Fish Collected	Condition
Threadfin shad	3-9	1-5	409	409 - dead, mechanical damage
White catfish	18.5	55	1	1 - dead, diseased
Brown bullhead	5-10	5-15	2	2 - dead, decomposed

[a] River temperatures 17.0-18.0 C.

Table A-6. Fish collected from Allen Steam Plant traveling screens, 20 November 1973.[a]

Species	Size Class (cm)	Weight Class (g)	Number of Fish Collected	Condition
Threadfin shad	3-9	1-5	5480	5480 - dead, mechanical damage
Bluegill	10	13	1	1 - alive, no apparent damage
Redbreast sunfish	3	<5	1	1 - alive, no apparent damage
White bass	15.5	75	1	1 - alive, mechanical damage
White catfish	5-20	<5-120	7	1 - alive, no apparent damage 6 - dead, decomposed

[a] River temperatures 14.5-15.0 C.

Table A-7. Fish collected from Allen Steam Plant traveling screens, 11 December 1973.[a]

Species	Size Class (cm)	Weight Class (g)	Number of Fish Collected	Condition
Threadfin shad	2-15	1-6	336	b
Channel catfish	8	5	1	1 - alive, no apparent damage
Yellow perch	11	15	1	1 - dead, decomposed

a Collection period = 16 hours. River temperature 11.0 C.

b Specimens collected ranged from living to dead and decomposed fish.

Table A-8. Fish collected from Allen Steam Plant traveling screens, 18 December 1973.[a]

Species	Size Class (cm)	Weight Class (g)	Number of Fish Collected	Condition
Threadfin shad	2-15	1-6	20,000-30,000	[b]
Gizzard shad	10	10	1	1 - dead, decomposed
Bluegill	2-3	5	5	5 - alive, no apparent damage
Pumpkinseed sunfish	2-4	5	2	2 - alive, no apparent damage
White catfish	11	10	1	1 - alive, no apparent damage
Mosquitofish	5	-	2	2 - alive, no apparent damage

[a] River temperatures 8.5-9.5 C.

[b] Numbers estimated from total weight of fish collected divided by mean weight of fish from a subsample of 100 fish. Specimens ranged from living fish with mechanical damage to dead and decomposed fish.

Table A-9. Fish collected from Allen Steam Plant traveling screens, 8 January 1974.[a]

Species	Size Class (cm)	Weight Class (g)	Number of Fish Collected	Condition
Threadfin shad	4-10	2-8	~10,600	11 - alive, mechanical damage all others - dead, mechanical damage
Gizzard shad	16-29	33-145	3	3 - alive, emaciated, mechanical damage
Channel catfish	5-10	5-15	18	4 - alive, no apparent damage 3 - alive, diseased 11 - dead, decomposed
White catfish	18-26	38-122	2	2 - dead, decomposed
Bluegill	10	14	1	1 - alive, diseased
Redbreast sunfish	6	4	1	1 - alive, diseased

[a] River temperature 9.5-10.0 C.

Table A-10. Fish collected from Allen Steam Plant traveling screens, 22 January 1974.[a]

Species	Size Class (cm)	Weight Class (g)	Number of Fish Collected	Condition
Threadfin shad	2-10	1-10	8536	[b]
Gizzard shad	13-16	20-30	3	-
Bluegill	5-10	5-10	2	2 - alive, no apparent damage
Redbreast sunfish	6	7	1	1 - alive, no apparent damage
Pumpkinseed sunfish	5	5	1	1 - alive, no apparent damage
Channel catfish	5-10	5-15	19	19 - alive, no apparent damage
White catfish	7-8	5-10	3	3 - alive, no apparent damage

[a] River temperature 10.5 C.

[b] At 0800 and 1600 hour collections shad were all recently dead (within 8 hours) with little evidence of mechanical damage except descaling. During 2400 hour collections, threadfin shad were about 75% alive but obviously weakened with, again, little evidence of mechanical damage. Numbers of shad collected decreased with time (i.e. 0800 hours - 4636; 1600 hours - 2738; 2400 hours - 1162). Fish were most concentrated on screens of units 4 and 5 at all collections periods.

Table A-11. Fish collected from Allen Plant traveling screens, 12 February 1974.[a]

Species	Size Class (cm)	Weight Class (g)	No. of Fish Collected	Condition
Threadfin shad	6.0-11.0	1-10	384	1 - alive, mechanical damage ~345 - dead, mechanical damage ~38 - dead, decomposed
Gizzard shad	15.5-22.5	25-100	2	1 - alive, diseased 1 - dead, diseased
Bluegill	5.0-9.5	1-10	7	6 - dead, no apparent damage 1 - dead, diseased
Redbreast sunfish	9.5 13.0	20 25	1 1	alive, no apparent damage diseased, dead
Pumpkinseed	7.5	10	1	dead, no apparent damage
Channel catfish	8.0-9.0	5	2	alive, diseased
White catfish	8.0-9.0	5-10	2	1 - dead, no apparent damage 1 - dead, diseased

[a] River temperature 9.0-9.5C.

Table A-12. Fish collected from Allen Steam Plant traveling screens, 26 February 1974.[a, b]

Species	Size Class (cm)	Weight Class (g)	Number of Fish Collected	Condition
Threadfin shad	2-10	2-10	629	~50 - dead, mechanical damage ~579 - dead, decomposed
Gizzard shad	8-22	5-80	7	7 - dead, decomposed
Yellow perch	11-16	10-45	2	2 - dead, decomposed
Bluegill	5-7	>5	5	4 - dead, decomposed 1 - alive, no apparent damage
Unidentifiable (sunfish)	6-7	>5	2	2 - dead, decomposed
Channel catfish	9-28	5-125	5	2 - dead, decomposed 3 - alive, no apparent damage
White catfish	8-11	5-10	3	1 - dead, decomposed 2 - alive, no apparent damage

a River temperature 9.5 - 10.0C.

b Screen monitoring period ~16 hours.

Table A-13. Fish collected from Allen Steam Plant traveling screens, 5 March 1974.[a]

Species	Size Class (cm)	Weight Class (g)	No. of Fish Collected	Condition
Threadfin shad	5-11	<5-10	62	59 - dead, mechanical damage 2 - dead, mechanical damage 1 - decomposed
Gizzard shad	8-10	4-10	3	3 - dead, mechanical damage
Bluegill sunfish	3-7.5	<5-10	4	3 - alive, no apparent damage 1 - dead, diseased
Pumpkinseed sunfish	3-5	1-7	2	1 - alive, diseased 1 - dead, mechanical damage

[a] River temperature 11.5 - 12.5 °C.

Table A-14. Fish collected from Allen Steam Plant traveling screens, 19 March 1974.[a]

Species	Size Class (cm)	Weight Class (g)	Number of Fish Collected	Condition
Threadfin shad	4.5-10.5	<5-10	8	8 - dead, mechanical damage
Gizzard shad	5.0-8.0	<5-10	6	6 - dead, mechanical damage
	17.5-23.0	100-120	2	1 - dead, mechanical damage
				1 - alive, emaciated, mechanical damage
Yellow perch	10.5-12.5	15-35	2	1 - dead, advanced decomposition
				1 - alive, weak, no apparent damage
Bluegill	12.5	55	1	1 - dead, advanced decomposition
	4.5-6.0	<5	4	4 - alive, no apparent damage
Redear sunfish	11.0	35	1	1 - alive, emaciated, mechanical damage
Satinfin shiner	5.0	<5	1	1 - dead, advanced decomposition
Channel catfish	8.0	10	1	1 - alive, no apparent damage

[a] River temperature 11.5-12.5 °C.

Table A-15. Fish collected from Allen Steam Plant traveling screens, 4 April 1974.[a, b]

Species	Size Class (cm)	Weight Class (g)	Number of Fish Collected	Condition
Threadfin shad	4.0-11.0	1-10	138	134 - dead, mechanical damage 3 - dead, diseased 1 - decomposed
Gizzard shad	7.0-12.0	3-15	38	38 - dead, mechanical damage
Yellow perch	8.5-16	5-35	27	22 - dead, no apparent damage 1 - alive, mechanical damage 3 - dead, mechanical damage 1 - dead, diseased
Bluegill	4.0-15	2-20	49	6 - alive, no apparent damage 33 - dead, no apparent damage 1 - alive, mechanical damage 6 - dead, mechanical damage 1 - alive, diseased 1 - dead, diseased 1 - decomposed
Pumpkinseed	5.5-8.0	2-6	9	3 - dead, no apparent damage 6 - dead, mechanical damage
Redbreast sunfish	6.5-8.0	5	2	1 - alive, no apparent damage 1 - dead, no apparent damage
Warmouth	9.5	4	1	1 - dead, mechanical damage
Redear sunfish	7.0-8.5	10	3	1 - alive, no apparent damage 2 - dead, mechanical damage

Table A-15. (continued)

Species	Size Class (cm)	Weight Class (g)	Number of Fish Collected	Condition
Black crappie	16.0	65	1	1 - dead, no apparent damage
Silvery minnow	8.0-8.5	5-6	4	4 - dead, mechanical damage
Golden shiner	11.5	10	1	1 - dead, mechanical damage
Channel catfish	9.0-15.0	6-25	4	4 - dead, diseased
White catfish	7.0-8.0	6	3	3 - dead, diseased

a River temperature 14.5-15.0°C.

b Units 1 and 2 off line: data for units 3-5.

Table A-16. Fish collected from Allen Steam Plant traveling screens, 16 April 1974[a, b]

Species	Size Class (cm)	Weight Class (g)	No. of Fish Collected	Condition
Threadfin shad	5.5-11.0	2-15	114	3 - alive, mechanical damage 95 - dead, mechanical damage 16 - dead, decomposed
Yellow perch	10.0-15.5	10-30	10	10 - dead, decomposed
Bluegill	5.0-13.5	2-55	74	49 - alive, no apparent damage 10 - alive, weak and emaciated 15 - dead, decomposed
Redbreast	8.5-14.0	10-50	2	1 - alive, no apparent damage 1 - dead, decomposed
Pumpkinseed	6.5-9.0	5-10	4	4 - alive, no apparent damage
Unidentifiable sunfish	10.0-12.0	20-35	2	2 - dead, decomposed
Warmouth	8.5-19.0	15-140	6	5 - alive, no apparent damage 1 - dead, decomposed
Largemouth bass	29.5	285	1	1 - alive, mechanical damage
Channel catfish	10.5	10	1	1 - alive, no apparent damage
Brown bullhead	18.0	60	1	1 - alive, fungus and mechanical damage

[a] River temperature 15.0 - 15.5C.
[b] Unit 1 off line; data for Units 2 through 5.

Table A-18. Fish collected from Allen Steam Plant traveling screens, 21 May 1974.[a]

Species	Size Class (cm)	Weight Class (g)	Number of Fish Collected	Condition
Threadfin shad	6.0-11.5	2-10	423	16 - alive mechanical damage 407 - dead, mechanical damage
Bluegill	4.5-11.5	2-20	22	16 - alive, no apparent damage 3 - dead, no apparent damage 3 - dead, decomposing
Pumpkinseed sunfish	12.0	25	1	1 - dead, diseased, mechanical damage
Channel catfish	9.0-17.0	10-40	4	4 - dead, decomposing
White catfish	8.5-10.5	10-15	3	2 - alive, no apparent damage 1 - dead, decomposing
Yellow perch	12.5	20	1	1 - dead, decomposing

[a] River temperature 21.5-22.0C.

Table A-19. Fish collecied from Allen Steam Plant traveling screens, 4 June 1974[a]

Species	Size Class (cm)	Weight Class (g)	Number of Fish Collected	Condition
Threadfin shad	5.5-7.0	2-5	151	3 - alive, mechanical damage 146 - dead, mechanical damage 2 - dead, advanced decomposition
Bluegill	3.5-5.5	<5-5	11	5 - alive, no apparent damage 1 - dead, no apparent damage 5 - dead, mechanical damage
	7.5-11.5	10-35	2	2 - dead, diseased
Redbreast sunfish	5.0	5	1	1 - dead, mechanical damage
Channel catfish	10.0-16.0	20-60	2	2 - alive, diseased
White catfish	7.5	10	1	1 - dead, no apparent damage
Yellow perch	15.0	50	1	1 - alive, diseased

[a] River temperature 23.5-23.9°C

Table A-20. Fish collected from Allen Steam Plant traveling screens, 18 June 1974.[a]

Species	Size Class (cm)	Weight Class (g)	Number of Fish Collected	Condition
Threadfin shad	3.5	<5	1	1 - dead, mechanical damage
Largemouth bass	20.5-22.0	115-145	2	1 - dead, mechanical damage 1 - dead, no apparent damage
Bluegill	3.5-5.5	5	4	1 - dead, no apparent damage 1 - alive, mechanical damage 1 - dead, mechanical damage 1 - alive, diseased
Redbreast sunfish	6.0-7.5	10	2	1 - alive, no apparent damage 1 - dead, no apparent damage

a River temperature 25.5-26.0C

Table A-21. Fish collected from Allen Steam Plant traveling screens, 2 July 1974.[a, b]

Species	Size Class (cm)	Weight Class (g)	Number of Fish Collected	Condition
Threadfin shad	6.5	5	1	1 - dead, mechanical damage
Gizzard shad	15.5-18.5	85-120	4	2 - dead, mechanical damage 2 - dead, decomposed
Bluegill	5.0-14.0	2-75	18	5 - alive, no apparent damage 13 - dead, decomposed
Golden shiner	4.5	2	1	1 - dead, mechanical damage
White catfish	9.5-19.0	15-80	12	2 - alive, diseased, mechanical damage 10 - dead, decomposed
Channel catfish	14.0-20.5	45-110	2	1 - dead, no apparent damage 1 - dead, decomposed

a River temperature 25.0-26.0C.

b Unit 5 not operational this date.

Table A-22. Fish collected from Allen Steam Plant traveling screens, 16 July 1974.[a]

Species	Size Class (cm)	Weight Class (g)	Number of Fish Collected	Condition
Threadfin shad	4.0-5.5	2-5	3	1 - alive, mechanical damage 2 - dead, mechanical damage
Gizzard shad	14.5	40	1	1 - dead, mechanical damage
Bluegill	5.5-12.0	5-50	7	3 - alive, no apparent damage 1 - alive, mechanical damage 2 - dead, mechanical damage 1 - dead, decomposed
Yellow perch	13.5	0.0	1	1 - dead, decomposed

[a] River temperature 28.0-28.5 C

Table A-23. Fish collected from Allen Steam Plant traveling screens, 6 August 1974.

Species	Size Class (cm)	Weight Class (g)	Number of Fish Collected	Condition
Threadfin shad	4.5-7.5	5	4	4 - dead, mechanical damage
Gizzard shad	18.5-30.5	95-170	2	2 - dead, mechanical damage
Bluegill	3.5-5.5	5	2	1 - alive, no apparent damage 1 - dead, mechanical damage
Channel catfish	14.5	55	1	1 - dead, diseased

[a] River temperature 27.2-27.8C

Table A-24. Fish collected from Allen Steam Plant traveling screens, 20 August 1974.[a]

Species	Size Class (cm)	Weight Class (g)	Number of Fish Collected	Condition
Threadfin shad	3.0-7.5	1-5	18	18 - dead, mechanical damage
Bluegill	5.0-13.5	5-75	6	2 - alive, no apparent damage 1 - alive, mechanical damage 3 - dead, decomposed
White bass	15.5	80	1	1 - dead, decomposed
White catfish	7.5-18.0	15-85	4	3 - dead, decomposed 1 - dead, no apparent damage
Channel catfish	10.0-17.0	10-70	3	2 - dead, mechanical damage 1 - dead, decomposed
Juveniles (unidentifiable)	2.0	0.2	2	2 - dead, no apparent damage

a River temperature 26.5-27.0C.